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Title: The reliability and validity of multiple mini interviews (MMIs) in values based recruitment to nursing, midwifery and paramedic practice: Findings from an evaluation study

Corresponding author; Dr Alison Callwood^a, a.callwood@surrey.ac.uk

^aSchool of Health Sciences, University of Surrey, Guildford, Surrey, GU2 7XH, UK, 01483 686747

Dr Debbie Cooke^a, d.cooke@surrey.ac.uk

Sarah Bolger^a, s.bolger@surrey.ac.uk

Dr Agnieszka Lemanska^a a.lemanska@surrey.ac.uk

Professor Helen Allan^b h.allan@mdx.ac.uk

^bCentre for Critical Research in Nursing and Midwifery, School of Health and Education, Middlesex University.

Abstract

Background: Universities in the United Kingdom (UK) are required to incorporate values based recruitment (VBR) into their healthcare student selection processes. This reflects an international drive to strengthen the quality of healthcare service provision. This paper presents novel findings in relation to the reliability and predictive validity of multiple mini interviews (MMIs); one approach to VBR widely being employed by universities.

Objectives: To examine the reliability (internal consistency) and predictive validity of MMIs using end of Year One practice outcomes of under-graduate pre-registration adult, child, mental health nursing, midwifery and paramedic practice students.

Design: Cross-discipline evaluation study.

Setting: One university in the United Kingdom.

Participants: Data were collected in two streams: applicants to A) The September 2014 and 2015 Midwifery Studies programmes; B) September 2015 Adult; Child and Mental Health Nursing and Paramedic Practice programmes. Fifty-seven midwifery students commenced their programme in 2014 and 69 in 2015; 47 and 54 agreed to participate and completed Year One respectively. 333 healthcare students commenced their programmes in September 2015. Of these, 281 agreed to participate and completed their first year (180 adult, 33 child and 34 mental health nursing and 34 paramedic practice students).

Methods: Stream A featured a seven station four-minute model with one interviewer at each station and in Stream B a six station model was employed. Cronbach's alpha was used to assess MMI station internal consistency and Pearson's moment correlation co-efficient to explore associations between participants' admission MMI score and end of Year One clinical practice outcomes (OSCE and mentor grading).

Results: Stream A: Significant correlations are reported between midwifery applicant's MMI scores and end of Year One practice outcomes. A multivariate linear regression model demonstrated that MMI score significantly predicted end of Year One practice outcomes controlling for age and academic entry level: coefficients 0.195 ($p=0.002$) and 0.116 ($p=0.002$) for OSCE and mentor grading respectively. In Stream B no significant correlations were found between MMI score and practice outcomes measured by mentor grading.

Internal consistency for each MMI station was 'excellent' with α values ranging from 0.966 – 0.974 across Streams A and B.

Conclusion: This novel, cross-discipline study shows that MMIs are reliable VBR tools which have predictive validity when a seven station model is used. These data are important given the current international use of different MMI models in healthcare student selection processes.

Key Words: midwifery, multiple mini interviews, nursing, paramedic, selection, values based recruitment

1. Introduction

New global directions for strengthening nursing and midwifery focus on ensuring an educated, competent, motivated and responsive workforce (World Health Organisation, WHO, 2016). The personal characteristics of healthcare providers feature in current international discussions around WHO's post-millennium development goals (WHO, 2012). This paper presents novel findings regarding the selection of adult, child and mental health nursing, midwifery and paramedic practice students using multiple mini interviews (MMIs) at one university in the United Kingdom (UK). It has international significance to care providers as they seek to enhance the quality of service provision through recruiting high quality staff.

Universities offering healthcare education programmes have a duty to adopt recruitment strategies that are as reliable, defensible and valid as possible (Rodgers *et al.*, 2013). The difficulties facing universities are the empirical judgements which have to be made about applicants' personal qualities during selection in the absence of substantive evidence (Patterson *et al.*, 2014). One-to-one and group interviews have been widely used to inform final decision-making however their ability to identify those most likely to be able to meet service user's multifarious needs has been questioned (Wilson *et al.*, 2012, Perkins *et al.*, 2013, Rodgers *et al.*, 2013). Decisions about candidates become more difficult when policy context changes (WHO, 2014 and 2016). Enhancements to existing European Union (EU) legislation governing admissions to nursing programmes have been proposed (EU, 2013). In the UK, the Government has mandated that recruitment into all newly-funded training posts should incorporate values based recruitment (VBR), or selection for 'values' from March, 2015 (Great Britain, Department of Health, DH, 2013).

VBR is the process of recruiting and selecting individuals for caring professions on the basis that their personal values align with the UK National Health Service (NHS) Constitution (DH, 2012). It is intuitively attractive to assume that by recruiting for these values the quality of health care provision will be enhanced but this is not substantiated by empirical evidence (Patterson *et al.*, 2014). To guide the implementation of VBR, Patterson *et al.* (2014) conducted a systematic review evaluating different interview approaches. Multiple mini interviews (MMIs) were identified as effective methods for selection but the limited evidence directly relating to their efficacy in a VBR context was acknowledged (Patterson, *et al.*, 2014).

2. Background

2.1 Multiple mini interviews

Interviewing candidates using MMIs is an admissions methodology designed to replace the personal interview. Eva *et al.*, (2004a) conceived, developed and tested the first MMI models with medical school applicants at McMaster University, Ontario in 2004. MMIs in dental, midwifery, nursing, pharmacology, paramedic, occupational therapy and emergency medicine student selection are being increasingly employed internationally (McAndrew *et al.*, 2012; Callwood *et al.*, 2014; Cameron *et al.*, 2012, Tavares *et al.*, 2015, Perkins *et al.*, 2013, Grice *et al.*, 2014, Soares *et al.*, 2015).

In MMIs, candidates are asked to respond to questions relating to a specific scenario at a 'station' and then move on to the next station in a timed circuit. 'Stations' typically comprises a table, two chairs for the interviewer and candidate, the scenario question and any accompanying resources and scoring pro forma. Scenarios are designed to assess pre-defined personal qualities (Eva *et al.*, 2004a). These short, focused interactions with different interviewers at each station aim to mitigate against interviewer bias (Eva *et al.*, 2004a). Proponents argue that the aggregate of multiple observations generated represents a more generalizable assessment of an individual's personal attributes than the personal interview (Eva *et al.*, 2004b, Roberts *et al.*, 2008, Roberts *et al.*, 2014).

MMIs are used internationally but evidence in relation to their reliability and validity in a VBR context is limited. This paper addresses this lack of research by reporting unpublished findings on the predictive validity and internal consistency of MMIs across professional groups. The authors suggest that, because of the generic principles underpinning the study design, these data contribute to the emerging theoretical knowledge base for MMI administration across healthcare student selection processes both within and outside a VBR context.

3. **Study objectives:** To examine the reliability (internal consistency) and predictive validity of MMIs using end of Year One practice outcomes of under-graduate pre-registration adult, child, mental health nursing, midwifery and paramedic practice students.

4. Design

A cross-discipline cohort study was conducted at one university in the UK (Table 2). Data were collected in two streams at the end of students' first year:

Stream A: September 2014 and 2015 midwifery cohorts

Stream B: September 2015 adult, child and mental health nursing and paramedic practice cohorts.

4.1 MMI model

Building on previous pilot work by Callwood *et al.*, (2014), the Delphi technique (Linstone, 1976) was employed to develop a desirable attributes/values profile for midwifery student selection in the 2013-14 recruitment cycle. These values were congruent with the NHS Constitution values (DH, 2012). To reflect the university's programme philosophy, 'kindness, compassion and empathy' and 'communication skills' were assessed as generic attributes at each station. This resulted in a seven station, four-minute model with one interviewer at each station, that is, four minute interviews with seven different interviewers. See Table 1 for individual interview foci across the seven different interviews.

Populating seven stations with interviewers was feasible in midwifery student selection due to a sizeable pool of willing volunteers from clinical practice. This was not available in adult, child, mental health nursing or paramedic practice student selection processes. A logistical and resource-driven decision was therefore taken to employ a six station four-minute model with one interviewer at each station for these programmes. To achieve this, stations assessing 'respect for difference and diversity' and 'respect for privacy and dignity' were combined into one station (Table 1). This was a pragmatic move underpinned by published findings that MMIs can assess multiple constructs (Oliver *et al.* 2014).

Table 1: Values/attributes assessed at each station

Table 1: Values/attributes assessed at each station

	Midwifery	Adult, child, mental health nursing, paramedic practice
Generic values/attributes	Communication skills, kindness, compassion, empathy	
Station specific values/attributes 1.	Motivation to become a nurse/midwife/paramedic	
2.	Intellectual curiosity and reflective nature	

3.	Initiative, problem solving and team work	
4.	Honest and integrity	
5.	Advocacy	
6.	Respect for privacy and dignity	Respect for privacy and dignity/ difference and diversity
7.	Respect for difference and diversity	

The scenarios used in the September 2014 and 2015 midwifery cohort selection were systematically developed and piloted at the University between 2011 and 2013 (Callwood et al., 2014) guided by DeVellis's framework for scale development (2003). Following similar principles a new pool of scenarios were written for the September 15 adult, child, mental health nursing and paramedic practice students. This study reports data relating to different scenarios in seven and six station models. An example scenario for assessing initiative, problem-solving and team work (Table 1, attribute 3) is presented (Box A).

Box A: Example scenario designed to assess initiative, problem solving and team work

You have been training for over a year to enter a race to ascent Mount Kilimanjaro. You begin the climb with your fellow competitors, all focused on being the first to reach the summit. Part way up one of the climbers falls critically ill with altitude sickness while two others develop diarrhoea and vomiting.

Concerns are raised about the rest of the climbers becoming ill, however one of your competitors decides he has trained for so long to achieve his dream that he goes on ahead alone.

You and two others are the only members of the party feeling fit and well.

How would you respond to this situation and why?

4.2 Data collection and participants

Using a non-probability consecutive sampling strategy, all applicants to the university's pre-registration September 2014 Midwifery and September 2015 adult, child and mental health nursing, paramedic practice and midwifery programmes were invited to participate. Detailed information about the study accompanied each applicant's invitation to interview. On their interview day, applicants had the opportunity to ask questions prior to agreeing to participate.

Of the n=126 midwifery students who commenced their programme in September 2014 and 2015, n=101 agreed to participate and completed their first year. Among the adult, child, mental health nursing and paramedic students who volunteered to take part, n=281 completed Year One (Table 2). This sample was sufficient to detect a correlation coefficient of 0.5 with 80% power in a two-sided significance test of 0.05 between MMI score and end of Year One clinical practice outcomes.

Table 2: Cohort sizes and number of students by professional groups.

	September 2014	September 2015	September 2015			
	Midwifery		Adult	Child	Mental health	Paramedic practice
Cohort size(programme commencement) N	57	69	199	41	45	48

Participants completing Year 1 N (% of cohort)	47 (82)	54 (78)	180 (90)	33 (80)	34 (75)	34 (71)
Total	101		247			34

4.3 Analysis

Participants were scored on a seven point Likert scale for ten criteria at each station, generating a total maximum possible score of 490 and 420 for a seven and six station models respectively. Once all raw scores were entered into SPSS, an independent researcher checked the accuracy of a random sample of 10%. A 93% accuracy score was reported therefore no further data checking was considered necessary.

Station internal consistency was assessed using Cronbach's alpha. To explore the predictive validity of MMIs, Pearson Product-Moment Coefficient was used to examine associations between applicants' MMI score and their end of Year One clinical practice performance outcomes. In adult, child, mental health nursing and paramedic practice programmes at this university, end of Year One performance in practice is assessed using mentor grading (Stream B). In midwifery programmes a postnatal objective structured clinical examination (OSCE) (Harden, 1979) is used in addition to mentor grading (Stream A). These are programme-specific differences not related to the study design. Data from the two streams were analysed separately due to the six and seven station models. Pearson Product-Moment Coefficient was also used to examine associations between age and practice performance outcomes. Academic entry level was a binary variable (A* level or ACESS**/BTEC***); an Independent Samples t-test was therefore employed to assess differences in mentor-grading and OSCE score between different academic entry levels.

A multivariate linear regression model was run on statistically significant findings to examine the effect on clinical practice outcomes (OSCE and mentor grading) of MMI score controlling for age and academic entry level.

It was not possible to assess concurrent validity as this study presents findings from a new values based recruitment tool.

5. Ethical approval

This study received a favourable decision from the university's Research Ethics Committee in November 2013 and July 2014 (reference number: EC/2011/12/FHMS).

6. Results

Across cohorts, seventy-six percent of participants were Caucasian British (71% adult, 75% child, 55% mental health nursing, 87% paramedic practice and 95% midwifery). 100% of participants had an IELTS (International English Language Test System) score of seven or above demonstrating proficiency in English language. Therefore neither ethnicity nor English language were confounding variables in this study.

Findings are presented according to the two data streams: (A) the September 2014 and 2015 midwifery students; (B) the September 2015 adult, child and mental, health nursing and paramedic practice students.

6.1 Data stream A: midwifery cohorts

There were no statically significant differences in age ($p=0.561$, t value = 0.583, df 114) and academic entry level ($p=0.585$, $\chi^2 = 0.298$, $df=1$) between the September 2014 and 2015 midwifery cohorts. In the September 2014 cohort, 98% of students were Caucasian British and 93% in the September 2015 cohort. All students had English as their first language. Their cohort data were combined in subsequent analysis.

6.1.1 Participant demographics

Participant demographics in relation to age and academic entry point are presented in Table 3.

Table 3: Student cohort demographics

	September 2014 midwifery participants (n=47)	September 2014 midwifery cohort (n=57)	September 2015 midwifery participants (54)	September 2015 midwifery cohort (n=69)
Mean Age (years) (SD)	22 (6.1)	25 (6.9)	23 (7.2)	24 (6.8)
Academic entry point N (%)				
3 A levels*	26 (52%)	29 (51%)	29 (54%)	38 (55%)
Access**/BTEC***	21 (48%)	28 (49%)	25 (46%)	31 (45%)

* A-levels are the traditional qualifications that are offered by schools and colleges for students aged between 16 and 19 in the U.K.
 **The Access to Higher Education (HE) Diploma is a U.K. qualification which prepares students who left school without qualifications like A levels, for study as an undergraduate at university.
 ***The BTEC Level 3 Extended Diploma is a secondary school leaving qualification and vocational qualification taken in England, Wales and Northern Ireland.

6.1.2 Association of Year One practice outcomes with age and academic entry level

No correlations were found between age and end of Year One practice outcomes (mentor-grading and OSCE scores) (Table 4). Similarly, there were no statistically significant differences academic entry level and practice outcomes (Table 5).

Significant correlations were found between midwifery students' mentor grading and OSCE scores suggesting overlap between these assessment measures. This is important to note as both were used in the MMI validity analysis, (Table 4).

Table 4: Correlation matrix: Year One practice outcomes and age

Midwifery students (2014 and 2015)				
	N	Age	Mentor grading	OSCE
Age	101	1	.009	-0.013
Mentor grading		0.009	1	.407*
OCSE		-0.013	0.407*	1

Significant at 0.05 level*

Table 5: Relationship between Year One practice outcomes and academic entry level

Midwifery students (2014 and 2015)						
OSCE	Academic entry level	N	Mean	t	df	p
	3 A levels	55	65.6	-0.178	44	ns
	ACCESS/BTEC	46	66.3			

Mentor Grading	3 A levels	55	81.0	-0.801	51	ns
	ACCESS/BTEC	46	75.6			

6.1.3 Reliability

Station internal consistency ranged between 0.966 and 0.975 across seven stations (Table 6).

Table 6: Station specific Cronbach's alpha values

Station	
	Seven stations Cronbach's alpha [^]
1	0.966
2	0.974
3	0.974
4	0.971
5	0.975
6	0.969
7	0.963
[^] Cronbach's alpha scores: ≥ 0.9 = excellent; $0.7 - < 0.9$ = good; $\leq 0.6 - < 0.7$ = acceptable, $\leq 0.5 - < 0.6$ = poor and < 0.5 = unacceptable (Tavakol and Dennick, 2011)	

6.1.4 Validity of MMIs

Statistically significant findings are reported between students' MMI scores and their performance in practice at the end of Year One, see Table 7.

Table 7: Correlation of MMI scores with Practice Outcomes

	Midwifery	
N	101	
Mentor grading	.315**	p=0.001
OSCE	.313**	P=0.001

** Significant at 0.01 level Pearson's moment correlation

In multivariate regression analyses MMI scores were positively associated with OSCE (0.195, $p=0.002$) and mentor grading (0.116 $p=0.002$) in the seven station model used in student midwife selection. Age and academic entry level were not significant predictors of OSCE score and mentor grading within the regression model.

6.2 Data stream B: adult, child, mental health and paramedic practice cohorts

Participant groups were representative of their cohorts in relation to age and academic entry point, Table 8.

Table 8: Student cohort demographics

	September 2015
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	Adult, child, mental health nursing participants (247)	Adult, child, mental health nursing cohorts (285)	Paramedic participants (34)	Paramedic cohorts (48)
Mean Age (years) (SD)	23 (7.4)	24 (6.9)	22 (4.4)	21 (4.7)
Academic entry point N (%)				
3 A levels*	90 (36%)	111 (38%)	14 (41%)	19 (39%)
Access**/BTEC***	157 (64%)	174 (62%)	20 (59%)	29 (61%)

6.2.1 Association of Year One practice outcomes with age and academic entry level

Non-significant correlations were found between age and academic entry level and end of Year One practice outcomes (mentor-grading) for adult, child, mental health nursing and paramedic practice students (Tables 9 and 10).

Table 9: Relationship between Year One practice outcomes: age and academic entry level (adult, child and mental health nursing cohorts)

	N		Age		Mentor grading	
Age	247		1		.078	
	Academic entry level	N	Mean	t	df	p
Mentor grading	3 A levels	90	74.84	-0.276	48	0.006
	ACCESS/BTEC	157	65.19			

Significant at 0.05 level*

Table 10: Relationship between Year One practice outcomes: age and academic entry level (paramedic practice cohorts)

	N		Age		Mentor grading	
Age	34		1		.082	
	Academic entry level	N	Mean	t	df	p
Mentor grading	3 A levels	14	82.50	-0.087	28	0.294
	ACCESS/BTEC	20	82.88			

6.2.2 Reliability

Station internal consistency ranged between 0.969 and 0.974 across six stations (Table 11).

Table 11: Station specific Cronbach's alpha values

Station	
	Six stations Cronbach's alpha^
1	0.970
2	0.969

3	0.973
4	0.970
5	0.974
6	0.969
^Cronbach's alpha scores: ≥ 0.9 = excellent; $0.7 - < 0.9$ = good; $\leq 0.6 - < 0.7$ = acceptable, $\leq 0.5 - < 0.6$ = poor and < 0.5 = unacceptable (Tavakol and Dennick, 2011)	

6.3.2 Validity

No significant associations are reported between adult, child, mental health nursing and paramedic practice students' MMI scores and their performance in practice at the end of Year One (Table 12).

Table 12: Correlation matrix: predictive validity of MMIs

	Nursing						Paramedic Practice	
	Adult		Child		Mental Health			
N	180		33		34		34	
Mentor grading	0.226	p=0.053	0.301	p=.119	0.083	p=.693	0.110	p=.548

** Significant at 0.01 level

7. Discussion

Education providers, health service commissioners and people who access healthcare services all consider the personal qualities of those delivering care to be fundamentally important (WHO, 2014). While international organisations like WHO (2016) lead on global strategic directions for enhancing care provision, assessing applicants' potential to meet service users' needs locally, remains challenging.

Examining the reliability and validity of MMIs is complex as outcomes can be influenced by the model being used: number of stations; time spent at each station; number of interviewers; scenario design and personal qualities being assessed (Rees et al, 2016). This paper reports novel findings from pre-registration adult, child, mental health nursing, paramedic practice and midwifery student selection incorporating six and seven station MMI model designs.

The 'excellent' internal consistency seen in our findings is interesting to note. Having examined previously published scoring pro forma (Eva *et al.*, 2004a) the criteria being assessed in this study are more in-depth with a potential score of 70 from ten criteria at each station (resulting in a possible total of 420 and 490 for six and seven stations respectively). This detailed assessment may have enhanced the reliability which is reflected in the high Cronbach's alpha scores reported. Age and academic entry level were not found to be confounders in the relationship between MMI score and practice outcomes.

The seven station model reports statistical significance in relation to two clinical practice outcome indicators. These findings concur with a recent systematic review (Rees et al., 2016) recommending a minimum of seven stations to enhance predictive validity. Consequently, the differences in findings between the seven station model used in the midwifery cohorts and the six station model used in the three fields of nursing (adult, child and mental health) and paramedic practice cohorts are interesting. Possible reasons could be attributed to the scenario design however further work is needed to explain this. This will be the focus of the longitudinal data collection underway in relation to these cohorts' second and third year practice performance outcomes.

Systematic reviews examining the utility of MMIs in healthcare student selection processes internationally report a diversity of different MMI models being used (Pau *et al.*, 2014, Rees *et al.*, 2016). To the authors' knowledge there are no published guidelines for optimal MMI development and model design to assist universities who wish to employ MMIs. This has important implications for best practice in MMI administration.

7.1 Study rigour

In midwifery student selection internal validity was determined by comparing students' MMI scores with two practice-related outcomes: mentor grading and assessment of clinical proficiency in a postnatal OSCE. The authors assumed that if an association were found between both, this would offer greater strength to the assumption that an association exists than would have been conferred by either single measure (Moran Ellis, *et al.*, 2006). The statistically significant association found between OSCE and mentor grading scores is noteworthy. It was important to ensure congruence between what was being assessed in the MMIs and what was being examined in clinical practice. To achieve this, the personal qualities featured in the MMIs were mapped against the practice assessment documentation.

To enhance reliability, particularly inter-rater reliability, training was offered to all interviewers (Lemay *et al.*, 2007) at the beginning of interview days. This approach ensured the timely teaching of essential MMI administration information as well as capturing busy professionals. To ensure parity of opportunity between candidates no trigger or prompt questions were included. It was important that interviewers understood this and only offered to repeat the scenario or ask the candidate if there was anything else they wished to add. Test-retest measures were not considered appropriate due to the potential confounding influence of the programme on students' performance.

The researcher was a member of academic staff at the university. To ensure study credibility the researcher did not contribute to any applicant's MMI score.

7.2 Limitations and recommendations

The authors acknowledge concerns relating to the use of mentor-grading as a proxy measure of clinical practice performance (Perry, 2015, Fisher *et al.*, 2017, Moran *et al.*, 2016). Where possible, associations with other practice performance indicators were included, for example the OSCE employed in midwifery. These were not available for all other healthcare programmes at the end of Year One but this will be addressed in on-going data collection at the end of Years Two and Three.

The scenarios used in the six station model were different from the seven station model. This was a developmental study where the author's wanted to generate ownership of the move to using MMIs at this university. In an iterative process they therefore sought academic and teaching staff volunteers from each of the programmes to develop new scenarios for the September 2015 cohorts' admissions processes.

This study presents findings from a multidisciplinary, single university perspective where the associated potential contextual biases are conceded. The limitations of the relatively short, one year follow-up duration are also recognised. This is being addressed with the continuance of this study to examine the clinical practice performance of participants at the end of Years Two and Three of their programmes. In addition the forthcoming September 2016 health care professional cohorts at the University have also been invited to participate in a similar study.

8. Conclusion

Recruiting and selecting healthcare professionals according to their individual attributes and values has widespread significance. WHO (2014) in its Global Strategy on Human Resources for Health emphasise the importance of developing more systematic approaches to patient engagement and empowerment by looking at the skills and competencies of health professionals. MMIs are used to inform final decisions in healthcare student selection processes internationally. In the UK they are one approach to student selection endorsed by Health Education England (HEE, 2014) in their national VBR programme. This study reports positive findings, in relation to the reliability (internal consistency) of MMIs. The results support MMIs as a valid measure of the future performance of students in practice when a seven station model is employed. MMIs were also found to be objective and not influenced by age or academic entry level. These outcomes have generic relevance in informing the national and international use of MMIs in healthcare professional selection processes.

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